REMARKS

Claims 1,2,4 and 6-14 are pending in the present application. Claims 1,2, 8 and 13 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Wachsman (US6,235,417) in view of Edlund et al. (US 5,217,506). Claim 14 stands rejected under 35 U.S.C. §103(a) as being unpatentable over van Hassel et al. (US6,565,632) in view of Edlund et al. Applicants acknowledge with appreciation that claims 4,6, 7, and 9-12 are objected to as being dependent upon a rejected base claim but would be allowable if rewritten in independent form including the limitation of the base claim and any intervening claims. With this response, claims 1, 4, 13, and 14 are amended. Reconsideration of the claims, in light of the amendments and the remarks that follow, is respectfully requested.

Waschman describes a hydrogen permeable membrane and system for isolating the hydrogen in a hydrogen-containing gas. "This novel two-phase conductor is particularly useful as a mixed hydrogen ion and electronic conducting membrane for separating hydrogen from a hydrogen-containing gas" (Abstract, emphasis added). The two-phase conducting membrane disclosed by Waschman provides electron conduction and hydrogen ion conduction to provide a reaction by which the hydrogen in the reformate gas is reduced and yields hydrogen gas. For example, in one embodiment of the Waschman invention, "a process for hydrogen separation... comprises contacting a first side of a gas impermeable mixed hydrogen ion and electronic conducting membrane with the hydrogen-containing gas at an elevated pressure concurrently with contacting a second opposite side of the membrane with a gas at a lower pressure than the hydrogen-containing gas. Hydrogen ions are withdrawn from the second opposite side of the membrane" (col. 3/ln. 29-36, emphasis added). Waschman does not disclose passing steam along any portion of the hydrogen-ion permeable membrane.

Like Waschman, Edlund also describes hydrogen permeable membranes and methods for isolating the hydrogen in a hydrogen containing gas. "Various hydrogen production and hydrogen sulfide decomposition processes are disclosed that utilize composite metal membranes that contain an intermetallic diffusion barrier separating a *hydrogen-permeable* base metal and a *hydrogen-permeable* coating metal" (Abstract, emphasis added). The Examiner cites Edlund as disclosing the use of steam as a sweep gas. "It is desired to recover substantially pure hydrogen, by use of a condensable sweep stream, such as steam. After permeated hydrogen is swept from

the permeate side of the composite membrane of the invention, the condensable sweep component is condensed and recycled... leaving substantially pure hydrogen". An inert sweep gas, in this case steam, is used to physically transport hydrogen gas that has permeated a hydrogen permeable membrane. The sweep gas is inert in that it does not contribute to the electrochemical reaction by which hydrogen is purified from a stream of reformate gas.

In contrast, the present invention provides a process for hydrogen separation using oxygen ion - electron mixed conducting membranes. The process for hydrogen separation includes reducing at least a portion of steam to produce purified hydrogen. Applicants have amended the claims to make explicit in the claims that which was implicit. For example, claim 1 as currently amended, now recites in part:

> A process for purifying hydrogen comprising:
>
> a. preparing a flow cell in which 2 gas flows are separated by an oxygen ion conducting two phase solid state membrane, wherein the first phase is ionically conducting and the second phase is electronically conducting...
>
> c. passing a stream of reformate gases on one side of said membrane and steam on the second side of said membrane, wherein at least a portion of the steam on the second side of said membrane is reduced to produce purified hydrogen...

Thus, the present invention includes oxygen ion conducting membranes and processes by which the conduction of oxygen ions through such membranes produces purified hydrogen.

Firstly, neither Waschman nor Edlund disclose the use of an oxygen ion - electron mixed conducting membrane for hydrogen separation. Secondly, neither Waschman nor Edlund teach a process wherein H_2O is a component of the electrochemical reaction yielding purified hydrogen. Using steam as an inert sweep gas that physically transports purified hydrogen gas is not the same as using steam "wherein at least a portion of the steam ... is reduced to produce hydrogen," as recited in amended claim 1 (emphasis added). Because Waschman and Edlund disclose the conversion of hydrogen-containing gases into hydrogen via a mechanism that provides for ***hydrogen ion*** transport across a membrane, one of skill in the art would find no reason or basis in these references to practice the claimed invention. For at least these reasons,

applicants believe claims 1, 13 and dependent claims thereon are allowable, as presently amended.

Van Hassel discloses an ion transport membrane assembly. "The membrane may be an oxygen transport membrane or a hydrogen transport membrane" (Abstract). Among the membrane materials disclosed by van Hassel is strontium doped lanthanum iron cobalt oxide having the composition $La_{(1-x)}Sr_xCo_{(1-y)}Fe_yO_3$, where $0<x<1$ and $0<y<1$ (Table 1, col. 4, lines 7-8). Van Hassel does not teach or suggest a process for hydrogen separation using oxygen ion – electron mixed conducting membranes wherein steam is reduced to produce purified hydrogen. The Examiner appears to suggest combining the teachings of Wachsman and Edlund with the materials disclosed by van Hassel would render obvious claim 14.

For reasons detailed above, Washman and Edlund do not disclose or render obvious the claimed invention. Furthermore, the teachings of van Hassel do not supply that which is missing from Wachsman and Edlund. Van Hessel does not disclose that oxygen-ion transport membranes could be used for hydrogen separation, as recited in the instant claims. Van Hessel certainly does not disclose a hydrogen separation process in which "at least a portion of the steam on the second side of said membrane is reduced to produce purified hydrogen." Furthermore, Applicants have amended claim 14 to recite, in part,

> ...preparing a flow cell in which 2 gas flows are separated by an oxygen-ion conducting solid state membrane selected from the group consisting of:
>
> $La_{(1-x)}Ca_xCo_{(1-y)}Fe_yO_3$, where $0<x<1$ and $0<y<1$;
>
> $La_{(1-x)}Sr_xCo_{y1}Fe_{y2}Ni_{y3}Cr_{y4}O_3$, where $x<1$ and $y1+y2+y3+y4=1$;
>
> yttria stabilized zirconia doped with an oxide selected from the group consisting of MnO_2, TiO_2, FeO, Cr_2O_3 and other transition metal oxides;
>
> undoped CeO_2;
>
> CeO_2 doped with an oxide selected from the group consisting of MnO_2, TiO_2, FeO, Cr_2O_3 and other transition metal oxides;
>
> RE_2O_3 doped CeO_2, where RE is Y, Yb, Sc, or Gd; and
>
> $La_{1-x}Sr_xMg_yGa_{1-y}O_3$, where $x<1$, $y<1$, and mixtures thereof...

wherein strontium doped lanthanum iron oxide of said composition is no longer included.

Applicants believe that in light of the arguments presented and in further view of amendments made, claim 14 is also allowable

In view of the above amendments, Applicants believe the pending application is in condition for allowance, and respectfully requests the Examiner to allow the claims to issue. A petition for a two-month extension of time accompanies this response, and the Commissioner is hereby authorized to charge the fee required for this extension to Deposit Account No. 08-0219. No other fees are believed to be due at this time. However, please charge any fees, or credit any overpayments, to Deposit Account No. 08-0219.

Respectfully submitted,

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